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A106.72:NC-13

COMPLETED

ORIGINAL

Germ Plasm Evaluation Program

Progress Report No. 8

Roman L. Hruska
U.S. Meat Animal Research Center

In cooperation with
Kansas State University
and the University of Nebraska

Agricultural Reviews and Manuals
Science and Education Administration
U.S. Department of Agriculture

ARM-NC-13

September 1980

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The cattle Germ Plasm Evaluation Program at the Roman L. Hruska U.S. Meat Animal Research Center is designed to characterize different biological types represented by breeds varying widely in characteristics such as milk production, growth, mature size and carcass composition. A major objective is to characterize breeds representing different biological types in different feed environments and production situations for the full spectrum of biological traits relating to economic beef production.

A coordinated research effort is employed involving scientists from the disciplines of animal breeding, reproductive physiology, nutrition, meats, and management systems. The program was initiated in 1969. Progress reports have been published annually summarizing current results from each cycle and phase of the program for traits of principal economic importance to the beef cattle industry.

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ISSN 0193-3787

II

CATTLE GERM PLASM EVALUATION PROGRAM[1]

PROGRESS REPORT NO. 8

ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER

The cattle Germ Plasm Evaluation Program has been conducted in three cycles. Cycle I involved breeding Hereford, Angus, Jersey, South Devon, Limousin, Simmental and Charolais bulls by artificial insemination (AI) to Hereford and Angus cows to produce three calf crops (Cycle I, Phase 2) in the spring of 1970, 1971 and 1972.

Cycle II, initiated with the 1972 breeding season, involved the Hereford and Angus cows used in the first cycle. These cows were bred by AI to Hereford, Angus, Red Poll, Brown Swiss, Gelbvieh, Maine Anjou and Chianina sires to produce two calf crops (Cycle II, Phase 2) in the spring of 1973 and 1974. In addition, in Cycle II, Phase 2, Red Poll and Brown Swiss cows were added to the program and mated to Hereford, Angus, Red Poll and Brown Swiss sires to provide for a four-breed diallel crossbreeding experiment.

Cycle III was initiated during the 1974 breeding season. In Cycle III, the Hereford and Angus cows used to initiate Cycles I and II were mated by AI to Hereford, Angus, Pinzgauer, Tarentaise, Brahman, and Sahiwal sires to produce two calf crops (Cycle III, Phase 2) in the spring of 1975 and 1976.

Fifteen of the Hereford and 16 of the Angus sires used in Cycle I were also used in Cycle II and Cycle III to insure a stable control population of Hereford and Angus reciprocal crosses that are used as a basis for comparison between different cycles and phases of the program. Within each cycle of sire breeds, foundation cows (Hereford and Angus, in Cycles I, II and III, plus Red Poll and Brown Swiss in Cycle II) are referred to as Phase 1. Their calves are called Phase 2, and the calves from Phase 2 cows are designated Phase 3. Specific mating plans for each cycle and phase of the program are provided in the appendix.

Previous progress reports have presented completed data for Cycles I, II and III and are available by request. Progress Report No. 1 (ARS-NC-13, 1974) included birth and weaning traits of Cycle I, Phase 2, calves and postweaning growth, feed efficiency and carcass and meat traits of the steers. Progress Report No. 2 (ARS-NC-22, 1975) included the growth, reproduction and maternal performance of Cycle I, Phase 2, females through 2 years of age and, for Cycle II, Phase 2, the preweaning traits for both calf crops and the steer postweaning traits for the 1973 calf crop. Progress Report No. 3 (ARS-NC-41, 1976) presented a complete summary and discussion of Cycle I, Phase 2, results

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[1]Roman L. Hruska U.S. Meat Animal Research Center, Science and Education Administration-Agricultural Research, U.S. Department of Agriculture, Clay Center, Nebr. 68933; Standardization Branch, Meat Quality Division, Food Safety and Quality Service, U.S. Department of Agriculture; Kansas State University, Manhattan; and the University of Nebraska, Lincoln, cooperating.

from birth through slaughter for steers and from birth through puberty for the heifers. Progress Report No. 4 (ARS-NC-48, 1976) included reproduction and maternal performance of Cycle I, Phase 2, cows as 3-year-olds, preweaning and postweaning information for Cycle I, Phase 3, calves, and postweaning steer data for the 1974 calf crop and postweaning heifer data for both calf crops of Cycle II, Phase 2, calves. For results on calving, reproduction and maternal performance of Cycle I, Phase 3, and Cycle II, Phase 2, cows as 2-year-olds, readers are referred to Progress Report No. 5 (ARS-NC-55, 1977). Progress Report No. 5 also included complete results for birth and weaning traits on Cycle III, Phase 2, calves. Progress Report No. 6 (ARM-NC-2, 1978) included postweaning growth, and carcass data of steers and growth, puberty and conception data of heifers in Cycle II, Phase 3 and Cycle III, Phase 2.

This report provides reproduction and maternal performance data for Cycle I, Phase 2, cows as 4-, 5-, 6-, 7- and 8-year-olds; Cycle II, Phase 2, cows as 3-, 4-, 5- and 6-year olds; Cycle II, Phase 3, cows as 2-year-olds and Cycle III, Phase 2 cows as 2-, 3- and 4-year-olds.

General releases of information on individual sires are not planned because erroneous conclusions may be drawn from the ranking of individual sires with the relatively small number of progeny per sire in this program. The objective of the program is to characterize breeds as representatives of different biological types. To do this effectively, a large sample of sires of each breed is necessary. Thus, the number of progeny per sire is generally low. A relatively large number of progeny per sire are required for a high level of accuracy in ranking individual sires on their breeding value for most economic traits.

CYCLE I, PHASE 2

Foundation Cows. The foundation Hereford and Angus cows used in the program were purchased as calves at weaning from commercial producers in Nebraska. The cows were 2 through 5 years of age, 2 through 6 years of age, and 3 through 7 years of age at calving in 1970, 1971 and 1972, respectively.

Sires. In Cycle I, 32 Hereford, 35 Angus, 33 Jersey, 28 South Devon, 20 Limousin, 28 Simmental and 26 Charolais bulls were used during the 1969, 1970, and 1971 breeding seasons. The Hereford and Angus bulls used in this program were sampled from bulls that had been selected on individual performance information, which was the basis for entering into the progeny testing programs of commercial artificial insemination organizations. The Jersey bulls were selected at random from two commercial AI organizations, and the South Devon bulls were sampled from an importation made in 1969 by a commercial organization. Simmental, Limousin and Charolais bulls were sampled from bulls available from commercial AI organizations and from the Canada Department of Agriculture for the Simmental and Limousin.

For a cooperative study with the Canada Department of Agriculture, Hereford-Angus, Jersey-Angus, Simmental-Angus and Charolais-Angus heifers were randomly selected at weaning time and shipped, 4 to 8 weeks after weaning, to the Research Station, Lethbridge, Alberta. There were 12 heifers

per breed group in 1970 and 10 heifers per breed group in 1971 and 1972. These females and their offspring were individually fed to evaluate efficiency of production.

Matings. Cycle I, Phase 2, yearling heifers were mated to Hereford, Angus, Brahman, Devon and Holstein bulls during a 45- to 46-day AI season and to Hereford and Angus bulls for a 21- to 24-day cleanup period in 1971, 1972 and 1973 (appendix table 3). As 2-year-old cows, they were mated to Hereford, Angus, Chianina, Gelbvieh and Maine Anjou bulls for a 42- to 45-day AI season and to Hereford and Angus bulls during a 22-day cleanup in 1972, 1973 and 1974. As 3-year-olds and above, the cows are being mated by natural service to Brown Swiss (predominantly European) bulls for 63 days.

Data Analysis. Calving difficulty, calf mortality, calf birth weight and preweaning growth were analyzed by least-squares procedures for unequal subclass numbers using a model that included the effects of breed of cow's sire, breed of cow's dam, cow age-year, sex, breed of cows sire-breed of cow's dam and breed of cow's dam-sex. Birth and 200-day weight and preweaning growth rate were adjusted to a steer basis by adjustment factors calculated from the data and shown in the table footnotes. Calf crop percentage, pregnancy rate, cow weights and heights were analyzed with a similar least-squares procedure except that sex and two-way interactions with sex were not included in the model.

Calving Difficulty. Calving difficulty scores were assigned to each calf at birth on the basis of the following system:

Score		
1	No difficulty	- Calves unassisted.
2	Little difficulty	- Assistance given by hand, but no jack or puller used; assistance actually may not have been required.
3	Moderate difficulty	- Assistance given with jack or calf-puller; some difficulty was encountered even with the puller being used.
4	Major difficulty	- Calf jack used and major difficulty encountered usually 30 minutes or more required to deliver calf.
5	Caesarean birth	- Performed after determination made that calf could not be delivered with a calf-puller.
6	Abnormal presentation	- Assistance given: posterior, head back, leg back, and so forth.

Summaries of calving difficulty in 4-, 5-, 6-, 7- and 8-year-old cows are provided in table 1. For these summaries, scores of 1 and 2 were combined and are designated no difficulty and scores of 3 and 4 were combined and are designated calf-puller.

Reproductive and Maternal Performance. Information is presented on rebreeding performance of 4-, 5-, 6-, 7-, and 8-year-olds in table 2. Least squares means for cow weight at fall palpation time and fall hip height measurements when cows were 7½- and 8½-years of age are also included in table 2. Preweaning growth and calf crop percentages are provided in table 1 for calves from these same cows.

CYCLE II, PHASE 2

Cows. The foundation Hereford and Angus cows used in Cycle I were continued in Cycle II of the program. The cows calving in 1973 were 4 to 8 years of age and in 1974 were 4 to 9 years of age. As previously indicated, mature Brown Swiss and Red Poll cows were added to these herds for the 1972 and 1973 breeding season.

Sires. In Cycle II, 15 Hereford, 16 Angus, 16 Red Poll, 11 Brown Swiss, 11 Gelbvieh, 18 Maine Anjou and 20 Chianina bulls were used during the 1972 and 1973 breeding seasons. The Hereford and Angus sires had also been used in Cycle I of the program, and the other bulls were sampled from commercial organizations. The Brown Swiss sires included four domestic bulls and seven bulls imported into Canada from Switzerland and Germany.

Birth, Preweaning and Postweaning Data. Data on calving difficulty and preweaning growth for both calf crops produced (1973-74) and postweaning growth, feed efficiency and carcass and meat traits for the first calf crop of Cycle II, Phase 2, were summarized previously (ARS-NC-22, Progres Report No. 2, 1975). In addition, steer postweaning data from the second calf crop, and heifer postweaning growth, puberty and conception for both calf crops were reported previously (ARS-NC-48, Progress Report No. 4, 1976). Data on calving difficulty, reproduction, maternal performance and size of 2-year-olds were presented in Progress Report No. 5 (ARS-NC-55, 1977).

Calving and Rebreeding. Data on calving difficulty, calf crop percentage and birth and weaning weights of calves from 3-, 4-, 5- and 6-year-old dams (born in 1973-74) are presented in table 3 for cows out of Hereford and Angus dams. Data on rebreeding performance and size as 3-, 4-, 5-, and 6-year-olds are given in table 4. The cows were bred by natural service to 3/4 Simmental bulls in 1975, 1976 and 1977 and to 7/8 Simmental bulls in 1978 and 1979.

Calving difficulty, calf mortality, calf birth weight and preweaning growth were analyzed by least-squares procedures for unequal subclass numbers using a model that included the effects of breed of dam's sire, breed of dam's dam, year-age of cow, sex of calf and two-way interactions. Birth and 200-day weight and preweaning growth rate were adjusted to a steer basis by adjustment factors calculated from the data and shown in table footnotes. Calf crop percentage, pregnancy rate, cow weights and cow heights were analyzed by similar least-squares procedures except that sex and interactions with sex were not included in the model.

CYCLE II, PHASE 3

Sires. The mating plans to produce Cycle II, Phase 3, calves are presented in appendix table 4. There were 13 Hereford, 14 Angus, 13 Santa Gertrudis and 14 Brangus sires used by AI to produce the two calf crops

(1975-76). These sires were sampled from commercial organizations, with the Hereford and Angus sires being the same as used in other cycles and phases of the program. Calves resulting from cleanup matings to Hereford and Angus sires were also included in this summary. Calving difficulty, calf survival and preweaning growth were presented in Progress Report No. 5 (ARS-NC-55, 1977). Postweaning growth and carcass data on steers and postweaning growth, puberty and conception data on heifers were summarized in Progress Report No. 6 (ARM-NC-2, 1978).

Calving and Rebreeding of 2-Year-Olds. Data on calving difficulty, calf crop percentage and birth and weaning weights of calves from 2-year-old dams (born in 1975-76) are presented in table 5 according to breed of cows sire. Data for corresponding breed groups on rebreeding performance and size as 2-year-olds are given in table 6.

Calving difficulty, calf mortality, calf birth weight and preweaning growth were analyzed by least-squares procedures for unequal subclass numbers using a model that included the effects of breed of dam's sire, breed of dam's dam, breed of sire, year, sex and two-way interactions. Birth and 200-day weight and preweaning growth rate were adjusted to a steer basis by adjustment factors calculated from the data and shown in table footnotes. Calf crop percentage, pregnancy rate, cow weight and cow height were analyzed by similar least-squares procedures except that sex and interactions with sex were deleted from the model.

Calving and Rebreeding as 3- and 4-year-olds. Data on calving difficulty, calf crop percentage and birth and weaning weights of calves from 3- and 4-year old dams (born in 1975-76) are given in table 7 according to breed of cows sire. Data for corresponding breed groups on rebreeding performance and size as 2-year-olds are given in table 8. The models for least-squares analyses were exactly the same as for calving and rebreeding traits as 2-year-olds except that effects of year-age of cow was included instead of effects of just year.

CYCLE III, PHASE 2

Cows. The foundation Hereford and Angus cows used to produce Phase 2 calves in Cycles I and II were continued in Cycle III of the program (appendix table 5). The two calf crops in Cycle III, Phase 2, were produced in 1975 and 1976.

Sires. There were 13 Hereford, 14 Angus, 17 Brahman, 6 Sahiwal, 9 Pinzgauer and 7 Tarentaise sires used during the 1974 and 1975 breeding seasons. The Hereford and Angus bulls had also been used in Cycle I and Cycle II of the program, and the Brahman bulls were sampled from commercial AI organizations or purebred Brahman herds. Semen was available from only two Sahiwal bulls (imported from Australia) and one Tarentaise bull for the 1974 breeding season. Semen was available on four additional Sahiwal bulls and six additional Tarentaise bulls for the 1975 breeding season to produce the Cycle III, Phase 2, calf crop in 1976.

A sample of about 32 heifers from each of the Angus-Hereford, Hereford-Angus, Brahman-Hereford, Brahman-Angus, Sahiwal-Hereford, Sahiwal-Angus, Pinzgauer-Hereford and Pinzgauer-Angus breed groups were transferred to the

U.S. Department of Agriculture Station at Brooksville, Fla., for an interregional study cooperative with the Florida Agricultural Experiment Station to evaluate genotype-environment interactions involving maternal traits. These heifers and those remaining at the Roman L. Hruska U.S. Meat Animal Research Center are being mated by natural service to bulls sampled from the same population of Red Poll (for first calf crop) and 7/8 Simmental (second through fourth calf crops) to evaluate reproduction and maternal performance in each environment. Calving traits and preweaning growth data for all calves born in 1975 and 1976 were presented in Progress Report No. 5 (ARS-NC-55, 1977). Postweaning growth, feed efficiency and carcass traits of steers and postweaning growth, puberty and conception of yearling heifers were presented in Progress Report No. 6 (ARM-NC-2, 1978).

Reproduction and Maternal Performance. Data on calving difficulty, rebreeding performance, size of cow, percentage calf crop and birth and weaning weight of progeny from 2-year-old Cycle III, Phase 2, females (born in 1975 and 1976) were summarized previously in Progress Report No. 7 (ARM-NC-6, 1979).

Data on calving difficulty, percentage calf crop and birth and weaning weight of progeny from 3- and 4-year-old Cycle III, Phase 2, females (born in 1975 and 1976) are presented in table 9. Data on rebreeding performance and size as 3- and 4-year-olds are given for the corresponding breed group in table 10. The Cycle III, Phase 2, females were bred as 2- and 3-year-olds to 7/8 Simmental sires. These data were analyzed by least-squares procedures using a model that included effects of breed of dam's sire, breed of dam's dam, year-age of cow and two-way interactions. Effects of sex of calf and two-way interaction of breed of dam's sire, breed of dam's dam and year-age with sex were also included in models for calving difficulty and birth and weaning weight of progeny.

TABLE 1. ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
CALVING DIFFICULTY, CALF CROP PERCENTAGE, CALF MORTALITY, BIRTH WEIGHT, WEANING WEIGHT
AND WEANING WEIGHT RATIO OF CALVES FROM 4-, 5-, 6-, 7- AND 8-YEAR OLD COWS[a]
CYCLE I, PHASE 2 - COWS BORN 1970-71-72

Breed of cow		No. calves	Type of parturition, %				Calf crop, %[c]		Calf mortality, %[d]		Calf weight, lb[e]		
Sire	Dam	born	No. diff.[b]	Calf-puller	C-section	Abn. presentation	Born	Weaned	Early	Late	Birth	200-day	200-day wt ratio[f]
Angus	Hereford	256	97.4	0.3	0.0	2.3	95.1	86.8	2.7	5.5	90.1	511	101.2
Hereford	Angus	272	95.5	3.0	0.4	1.2	95.7	89.6	4.4	1.5	91.1	499	98.8
	Average	528	96.4	1.7	0.2	1.7	95.4	88.2	3.6	3.5	90.6	505	100.0
Jersey	Hereford	241	98.4	0.8	0.0	0.8	96.2	91.0	3.8	1.7	84.6	523	103.6
	Angus	190	97.9	0.5	0.0	1.6	90.4	81.9	4.7	4.7	80.4	512	101.4
	Average	431	98.1	0.7	0.0	1.2	93.3	86.4	4.2	3.2	82.5	517	102.4
South Devon	Hereford	219	93.8	2.9	0.5	2.8	93.3	90.0	1.3	2.7	97.3	526	104.2
	Angus	192	94.0	2.4	0.0	3.6	93.0	89.4	2.5	1.1	92.0	521	103.2
	Average	411	93.9	2.7	0.2	3.2	93.1	89.7	1.9	1.9	94.7	523	103.6
Limousin	Hereford	302	96.2	2.0	0.0	1.7	93.6	87.4	4.9	1.9	94.2	519	102.8
	Angus	307	94.3	2.5	0.3	2.9	97.8	91.1	6.1	1.0	89.4	510	101.0
	Average	609	95.2	2.3	0.2	2.3	95.7	89.2	5.5	1.4	91.8	514	101.8
Simmental	Hereford	348	91.2	5.9	0.6	2.3	96.1	91.0	5.2	0.9	96.9	554	109.7
	Angus	276	93.6	3.6	0.0	2.9	92.8	84.9	5.8	1.8	93.6	550	108.9
	Average	624	92.4	4.7	0.3	2.6	94.5	88.0	5.5	1.4	95.3	552	109.3
Charolais	Hereford	290	91.5	4.1	1.0	3.4	95.3	85.8	6.8	3.8	96.7	536	106.1
	Angus	193	92.3	3.1	0.5	4.1	91.6	83.8	6.6	2.6	96.3	536	106.1
	Average	483	91.9	3.6	0.8	3.7	93.5	84.8	6.7	3.2	96.5	536	106.1
Average	Hereford	1656	94.8	2.7	0.4	2.2	94.9	88.7	4.1	2.8	93.3	528	104.6
all sire	Angus	1430	94.5	2.5	0.2	2.7	93.6	86.8	5.0	2.1	90.5	521	103.2
breeds	Average	3086	94.7	2.6	0.3	2.5	94.2	87.7	4.6	2.4	91.9	525	104.0

[a] Calves from these cows were sired by Brown Swiss bulls (appendix table 3).

[b] No assistance or minor hand assistance.

[c] Of cows alive at calving; cows removed from experiment only for serious injury, being open two successive years or by death.

[d] Early mortality is within 72 hr of birth; late is from 72 hr after birth until weaning.

[e] Adjusted to a steer basis. Least-squares adjustment factors for heifers were 6.7 lb for birth weight and 34 lb for 200-day weight.

[f] Ratio computed relative to 505 lb average for Hereford and Angus sired dams.

TABLE 2. ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
CALVING DATE, REBREEDING PERFORMANCE AND SIZE OF COWS CALVING AS 7- AND 8-YEAR OLD COWS
CYCLE I, PHASE 2 - COWS BORN 1970-71-72

Breed of cow		No. cows		Avg. calving	Percent	Cow weight, lb		Hip height, in	
Sire	Dam	7-Yr olds	8-Yr olds	date[a]	preg.[b]	7½ years	8½ years	7½ years	8½ years
Angus	Hereford	53	37	March 31	95.4	1219	1220	48.7	48.8
Hereford	Angus	59	42	April 4	94.9	1231	1224	48.6	48.8
	Average	112	79	April 2	95.2	1225	1222	48.6	48.8
Jersey	Hereford	50	45	March 29	97.5	1071	1070	48.7	48.8
	Angus	42	25	March 29	91.5	1067	1046	48.2	47.8
	Average	92	70	March 29	94.5	1069	1058	48.4	48.3
South Devon	Hereford	47	23	April 6	94.0	1277	1280	50.8	50.9
	Angus	41	32	April 1	93.6	1254	1244	50.4	50.4
	Average	88	55	April 3	93.8	1266	1262	50.6	50.6
Limousin	Hereford	70	36	April 4	95.1	1240	1241	50.9	50.7
	Angus	67	41	March 31	96.6	1230	1231	50.2	50.0
	Average	137	77	April 2	95.9	1235	1236	50.6	50.3
Simmental	Hereford	77	46	April 5	95.2	1273	1281	51.5	51.4
	Angus	62	45	April 1	94.4	1291	1254	50.8	50.7
	Average	139	91	April 3	94.8	1282	1268	51.1	51.0
Charolais	Hereford	63	41	April 4	96.0	1367	1352	51.3	51.2
	Angus	44	25	April 4	94.1	1347	1354	51.0	51.0
	Average	107	66	April 4	95.1	1357	1353	51.2	51.1
Average	Hereford	360	228	April 3	95.5	1241	1241	50.3	50.3
all sire	Angus	315	210	April 1	94.2	1237	1226	49.9	49.8
breeds	Average	675	438	April 2	94.9	1239	1233	50.1	50.0

[a] Includes cows calving at 4-, 5-, 6-, 7- and 8-years of age.

[b] Breeding period was 63 days by natural service to Brown Swiss bulls (appendix table 3). Percent pregnant = no. palpated as pregnant - no. palpated, and only includes cows that calved prior to breeding.

TABLE 3. ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
CALVING DIFFICULTY, CALF CROP PERCENTAGE, CALF MORTALITY, BIRTH WEIGHT, WEANING WEIGHT
AND WEANING WEIGHT RATIO OF CALVES FROM 3-, 4-,5- AND 6-YEAR-OLD COWS[a]
CYCLE II, PHASE 2 - COWS BORN 1973-74

Breed of cow		No.	Type of parturition, %				Calf crop, %[c]		Calf mortality, %[d]		Calf weight, lb[e]		
Sire	Dam	calves born	No diff.[b]	Calf-puller	C-section	Abn. presentation	Born	Weaned	Early	Late	Birth	200-day	200-day wt ratio[f]
Angus	Hereford	108	94.1	3.3	0.0	2.6	91.6	87.4	3.0	1.5	87.0	483	100.2
Hereford	Angus	158	82.2	15.4	0.0	2.4	97.9	92.9	2.4	3.2	88.8	480	99.6
	Average	266	88.1	9.4	0.0	2.5	94.7	90.2	2.7	2.4	87.9	482	100.0
Red Poll	Hereford	114	84.9	12.5	0.0	2.7	93.9	84.6	6.7	3.2	91.8	511	106.0
	Angus	149	91.2	4.6	0.1	4.2	93.4	84.8	7.5	1.6	87.1	502	104.1
	Average	263	88.0	8.5	0.0	3.4	93.6	84.7	7.1	2.4	89.5	506	105.0
Brown Swiss	Hereford	201	85.7	9.6	1.2	3.5	95.7	89.9	4.6	1.4	95.2	542	112.4
	Angus	197	95.2	2.3	0.6	1.9	99.4	93.6	3.8	2.3	90.1	540	112.0
	Average	398	90.4	5.9	0.9	2.7	97.6	91.8	4.2	1.8	92.6	541	112.2
Gelbvieh	Hereford	126	90.0	7.1	0.1	2.8	99.2	93.3	2.6	3.9	93.2	543	112.7
	Angus	135	94.8	2.7	0.7	1.8	99.3	89.5	8.3	1.6	87.9	537	111.4
	Average	261	92.4	4.9	0.4	2.3	99.3	91.4	5.5	2.8	90.6	540	112.0
Maine Anjou	Hereford	127	89.3	7.7	0.0	3.1	95.7	89.0	2.9	4.2	98.9	535	111.0
	Angus	150	91.1	6.9	0.0	2.0	95.8	91.1	2.6	1.9	96.9	521	108.1
	Average	277	90.2	7.3	0.0	2.5	95.8	90.1	2.8	3.0	97.9	528	109.5
Chianina	Hereford	131	95.0	3.5	0.4	1.1	96.2	91.7	1.4	3.2	100.2	535	111.0
	Angus	142	93.1	5.8	0.5	0.6	97.7	91.0	4.1	2.4	95.3	529	109.8
	Average	273	94.0	4.6	0.5	0.8	97.0	91.3	2.7	2.8	97.7	532	110.4
Average	Hereford	807	89.8	7.3	0.3	2.6	95.4	89.3	3.5	2.9	94.4	525	108.9
all sire	Angus	931	91.3	6.3	0.3	2.2	97.3	90.5	4.8	2.2	91.0	518	107.5
breeds	Average	1738	90.6	6.8	0.3	2.4	96.3	89.9	4.2	2.5	92.7	522	108.3

[a] Calves from these cows were sired by 3/4 or 7/8 Simmental bulls (appendix table 4).

[b] No assistance or minor hand assistance.

[c] Of cows alive at calving; cows removed from experiment only for serious injury, being open two successive years or by death.

[d] Early mortality is within 72 hr of birth; late is from 72 hr after birth until weaning.

[e] Adjusted to a steer basis. Least-squares adjustment factors for heifers were 6.8 lb for birth weight and 32 lb for 200-day weight.

[f] Ratio computed relative to 482 lb average for Hereford and Angus sired dams.

TABLE 4. ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
CALVING DATE, REBREEDING PERFORMANCE AND SIZE OF COWS CALVING AS 3-, 4-, 5- AND 6-YEAR-OLD COWS
CYCLE II, PHASE 2 - COWS BORN 1973-74

Breed of cow		No. Cows				Avg.		Cow weight, lb		Cow hip height, in	
Sire	Dam	3-Yr olds	4-Yr olds	5-Yr olds	6-Yr olds	calving date	Percent preg.[a]	5½ years	6½ years	5½ years	6½ years
Angus	Hereford	38	34	32	13	March 30	94.5	1169	1239	48.2	49.5
Hereford	Angus	48	48	46	19	April 2	95.9	1113	1192	47.8	48.8
	Average	86	82	78	32	March 31	95.2	1141	1215	48.0	49.2
Red Poll	Hereford	38	38	35	9	March 30	95.2	1109	1121	48.8	48.9
	Angus	49	49	44	15	March 30	92.0	1102	1114	48.2	48.9
	Average	87	87	79	24	March 30	93.6	1106	1117	48.5	48.9
Brown Swiss	Hereford	65	63	60	23	April 1	98.7	1157	1228	50.7	51.6
	Angus	62	61	57	19	March 30	98.5	1134	1199	50.0	50.7
	Average	127	124	117	42	March 31	98.6	1146	1214	50.3	51.2
Gelbvieh	Hereford	37	35	34	18	April 2	97.5	1202	1267	51.1	51.3
	Angus	40	40	39	17	March 31	97.6	1189	1257	50.0	50.7
	Average	77	75	73	35	April 1	97.5	1195	1262	50.5	51.0
Maine Anjou	Hereford	38	38	38	18	March 30	95.8	1286	1369	51.3	52.1
	Angus	48	48	42	17	March 31	94.8	1275	1346	50.6	50.8
	Average	86	86	80	35	March 30	95.3	1281	1358	51.0	51.4
Chianina	Hereford	42	42	41	11	April 2	96.4	1283	1411	54.4	55.7
	Angus	44	43	43	14	March 31	96.0	1266	1599	53.5	51.8
	Average	86	85	84	25	April 1	96.2	1274	1505	53.9	53.7
Average	Hereford	258	250	240	92	March 31	96.4	1201	1273	50.8	51.5
all sire	Angus	291	289	271	101	March 31	95.8	1180	1285	50.0	50.3
breeds	Average	516	538	511	193	March 31	96.1	1190	1279	50.4	50.9

[a] Breeding period was 63 days by natural service to 3/4 or 7/8 Simmental bulls (appendix table 4). Percent pregnant = no. palpated as pregnant ÷ no. palpated, and only include cows that calved prior to breeding.

TABLE 5. ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
CALVING DIFFICULTY, CALF CROP PERCENTAGE, CALF MORTALITY, BIRTH WEIGHT, WEANING WEIGHT AND WEANING WEIGHT RATIO OF CALVES FROM 2-YEAR-OLD COWS[a]

Breed of cow		No. calves born	Type of parturition, %				Calf crop,[c] %		Calf mortality,[d] %		Calf weight, lb[e]		
Sire	Dam		No. diff.[b]	Calf puller	C-section	Abn. presentation	Born	Weaned	Early	Late	Birth	200-day wt.	200-day wt. ratio[f]
Angus	Hereford	35	61.5	28.9	8.7	2.7	87.1	76.4	4.9	3.6	76.9	428	98.2
Hereford	Angus-crosses	40	36.7	54.7	4.7	4.6	90.6	73.7	20.2	2.7	76.4	445	102.1
	Average	75	49.1	41.8	6.7	3.6	88.8	75.0	12.6	3.1	76.7	436	100.0
Brangus	Hereford-crosses	31	60.0	28.4	9.4	2.2	92.7	90.1	3.2	1.2	77.8	475	108.9
Hereford	Angus-crosses	24	42.2	38.3	4.7	14.8	86.0	74.2	6.7	7.3	79.9	475	108.9
	Average	55	51.1	33.3	7.1	8.5	89.4	82.2	4.9	4.2	78.9	475	108.9
Santa Gertrudis	Hereford-crosses	21	78.0	19.4	0.0	4.2	100.9	92.9	9.1	0.0	75.3	485	111.2
	Angus-crosses	19	69.5	10.7	13.6	6.1	99.4	75.5	17.6	0.0	81.7	487	111.7
	Average	40	73.8	15.0	6.0	5.2	97.3	84.2	13.4	0.0	78.5	486	111.5
Average	Hereford-crosses	87	66.5	25.6	6.0	3.0	93.6	86.5	5.7	1.6	76.7	463	106.1
all sire	Angus-crosses	83	49.5	34.6	7.7	8.5	92.0	74.5	14.8	3.3	79.3	469	107.6
breeds	Average	170	58.0	30.1	6.8	5.8	92.8	80.5	10.3	2.5	78.0	466	106.8

[a] Calves from these cows were sired by Shorthorn bulls.
[b] No assistance or minor hand assistance.
[c] Of cows palpated at end of previous breeding season.
[d] Early mortality is within 72 hr of birth; late is from 72 hr after birth until weaning.
[e] Adjusted to a steer basis. Least-squares adjustment factors for heifers were 5.9 lb for birth weight and 28 lb for 200-day weight.
[f] Ratio computed relative to 436 lb average for Hereford and Angus.

TABLE 6. ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
CALVING DATE, REBREEDING PERFORMANCE AND SIZE OF COWS CALVING AS 2-YEAR-OLDS
CYCLE II, PHASE 3 - COWS BORN IN 1975-76

Breed of cow		No. calving as 2-year-olds	Avg. calving date	Percent preg.[a]	Cow weight, lb	Condition score[b]
Sire	Dam				2 1/2 years	2 1/2 years
Angus	Hereford-crosses	35	March 11	96.9	1006	6.3
Hereford	Angus-crosses	40	March 16	87.2	1000	6.6
	Average	75	March 13	92.1	1003	6.4
Brangus	Hereford-crosses	31	March 13	92.5	1016	5.9
	Angus-crosses	24	March 16	91.6	1023	6.0
	Average	55	March 15	92.0	1020	5.9
Santa Gertrudis	Hereford-crosses	21	March 10	81.5	1027	6.3
	Angus-crosses	19	March 10	85.6	1040	5.9
	Average	40	March 10	83.6	1033	6.1
Average	Hereford-crosses	87	March 11	90.3	1016	6.2
all sire	Angus-crosses	83	March 14	88.1	1021	6.2
breeds	Average	170	March 13	89.2	1018	6.2

[a] Breeding period was 63 days by natural service to 7/8 Simmental bulls. Percent pregnant = no. palpated as pregnant ÷ no. palpated, and only includes cows that calved prior to breeding.
[b] Condition is scored on a scale of 1 to 9; 1 = thin, emaciated; 5 = average; 9 = very fat.

TABLE 7. ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
CALVING DIFFICULTY, CALF CROP PERCENTAGE, CALF MORTALITY, BIRTH WEIGHT, WEANING
WEIGHT AND WEANING WEIGHT RATIO OF CALVES FROM 3- AND 4-YEAR-OLD COWS[a]
CYCLE II, PHASE 3, - COWS BORN IN 1975-76

Breed of cow		No.	Type of parturition, %				Calf crop, %[d]		Calf mortality, %[e]		Calf weight, lb[f]		
Sire	Dam[b]	calves born	No diff.[c]	Calf-puller	C-section	Abn. presentation	Born	Weaned	Early	Late	Birth	200-Day	200-Day wt. ratio[g]
Angus	Hereford-X	39	87.2	8.7	0.7	3.4	98.5	84.8	16.2	0.0	80.0	494	101.0
Hereford	Angus-X	46	88.6	8.4	2.1	0.9	95.1	96.5	0.6	1.1	86.5	485	99.2
	Average	85	87.9	8.6	1.4	2.2	96.8	90.7	8.4	0.1	83.2	489	100.0
Brangus	Hereford-X	37	90.7	6.0	0.0	3.4	93.0	87.5	4.0	0.5	87.7	508	103.9
	Angus-X	29	87.7	8.1	0.0	4.8	97.9	85.5	13.7	1.0	87.2	521	106.5
	Average	66	89.2	7.1	0.0	4.1	95.4	86.5	8.8	0.8	87.5	515	105.3
Santa	Hereford-X	22	86.5	6.4	0.3	6.8	94.6	88.2	7.9	0.0	85.8	509	104.1
Gertrudis	Angus-X	20	100.0	0.0	0.5	3.3	96.2	91.8	0.0	5.2	82.9	512	104.7
	Average	42	97.1	0.0	0.4	5.0	95.4	90.0	3.6	1.6	84.4	511	104.5
Average	Hereford-X	98	88.1	7.1	0.3	4.5	95.3	86.9	9.4	0.0	84.5	503	102.9
all sire	Angus-X	95	94.7	1.7	0.7	3.0	96.4	91.2	4.5	2.5	85.5	506	106.5
breeds	Average	193	91.4	4.4	0.5	3.8	95.9	89.0	6.9	0.8	85.0	505	106.3

[a] Calves from these cows were sired by 7/8 Simmental bulls.
[b] Hereford-X denotes Hereford crosses and Angus-X denotes Angus crosses.
[c] No assistance or minor hand assistance.
[d] Of cows palpated at end of previous breeding season.
[e] Early mortaltiy is within 72 hr of birth; late is from 72 hr after birth until weaning.
[f] Adjusted to a steer basis. Least-squares adjustment factors for heifers were 4.9 for birth weight and 16 lb. for 200-day weight.
[g] Ratio computed relative to 489 lb. average for Hereford and Angus sired dams.

TABLE 8. ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
CALVING DATE, REBREEDING PERFORMANCE AND SIZE OF COWS CALVING AS 3- AND 4-YEAR-OLDS
CYCLE II, PHASE 3 - COWS BORN IN 1975-76

Breed of cow		No. calving as		Avg.	Percent	Cow weight, lb		Condition score[c]	
Sire	Dam[a]	3-Yr. olds	4-Yr. olds	calving date	preg.[b]	3½ years	4½ years	3½ years	4½ years
Angus	Hereford-X	28	11	March 26	96.1	1103	1220	6.6	5.9
Hereford	Angus-X	33	13	April 4	88.4	1073	1101	6.3	6.5
	Average	61	24	March 30	92.2	1088	1161	6.4	6.2
Brangus	Hereford-X	30	10	March 27	89.9	1083	1185	5.9	6.0
	Angus-X	23	6	April 6	95.2	1987	1201	5.7	5.9
	Average-X	53	16	April 1	92.5	1085	1193	5.8	5.9
Santa Gertrudis	Hereford-X	18	5	March 29	84.6	1117	1293	5.8	6.9
	Angus-X	15	4	March 30	87.2	1120	1218	5.2	6.0
	Average	33	9	March 30	85.9	1119	1255	5.5	6.5
Average	Hereford-X	76	26	March 27	90.2	1101	1232	6.1	6.3
all sire	Angus-X	71	23	April 3	90.2	1093	1173	5.7	6.2
breeds	Average	147	49	March 31	90.2	1097	1203	5.9	6.2

[a] Hereford-X denotes Hereford crosses and Angus-X denotes Angus crosses.
[b] Breeding period was 63 days by natural service to 7/8 Simmental bulls. Percent pregnant = no. palpated as pregnant ÷ no. palpated, and only includes cows that calved prior to breeding
[c] Condition is scored on a scale of 1 to 9; 1 = thin, emaciated; 5 = average; 9 = very fat

TABLE 9. ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
CALVING DIFFICULTY, CALF CROP PERCENTAGE, CALF MORTALITY, BIRTH WEIGHT,
WEANING WEIGHT AND WEANING WEIGHT RATIO OF CALVES FROM 3- AND 4-YEAR-OLD COWS[a]
CYCLE III, PHASE 2 - COWS BORN 1975-76

Breed of cow		No. calves born	Type of parturition, %				Calf crop, %[c]		Calf mortality, %[d]		Calf weight, lb[e]		
Sire	Dam		No. diff.[b]	Calf puller	C-section	Abn. presentation	Born	Weaned	Early	Late	Birth	200-day	200-day wt ratio[f]
Angus	Hereford	49	85.1	10.2	0.1	4.6	95.0	85.6	9.1	0.7	84.8	460	101.8
Hereford	Angus	111	84.9	11.8	0.0	3.3	92.6	88.6	5.2	0.0	81.6	445	98.5
	Average	160	85.0	11.0	0.0	4.0	93.8	87.1	7.2	0.0	83.2	452	100.0
Pinzgauer	Hereford	67	85.1	13.3	0.0	1.6	93.8	83.8	4.5	5.7	88.8	488	108.0
	Angus	101	90.8	7.9	0.8	0.4	94.7	91.4	3.8	0.7	86.4	488	108.0
	Average	168	88.0	10.6	0.4	1.0	94.3	87.6	4.1	3.2	87.6	488	108.0
Tarentaise	Hereford	43	90.8	6.7	0.1	2.4	87.7	83.1	2.3	2.3	86.4	512	113.3
	Angus	56	91.7	3.0	2.0	3.3	84.3	79.7	4.7	0.4	82.0	499	110.4
	Average	99	91.2	4.9	1.0	2.9	86.0	81.4	3.5	1.4	84.2	506	112.0
Brahman	Hereford	70	99.7	0.0	0.2	0.1	95.8	90.0	3.2	3.9	80.1	524	115.9
	Angus	91	98.2	0.0	0.0	1.8	92.8	84.8	5.5	2.9	76.8	523	115.7
	Average	161	99.0	0.0	0.1	0.9	94.3	87.4	4.4	3.4	78.4	524	115.9
Sahiwal	Hereford	43	95.8	4.4	0.0	0.0	95.3	88.8	4.4	2.3	74.0	490	108.4
	Angus	70	98.5	1.0	0.0	0.4	96.8	87.0	2.9	6.9	70.1	493	109.1
	Average	113	97.2	2.7	0.0	0.2	96.0	87.9	3.7	4.6	72.0	491	108.6
Average	Hereford	272	91.3	6.9	0.0	1.7	93.5	86.3	4.7	3.0	82.8	495	109.5
all sire	Angus	429	92.9	4.8	0.5	1.8	92.2	86.3	4.4	2.1	79.4	490	108.4
breeds	Average	701	92.1	5.8	0.3	1.8	92.9	86.3	4.6	2.5	81.1	492	108.9

[a] Calves from these cows were sired by 7/8 Simmental bulls.
[b] No assistance or minor hand assistance.
[c] Of cows alive at calving; cows removed from experiment only for serious injury, by death or being open two consecutive seasons.
[d] Early mortality is within 72 hr of birth; late is from 72 hr after birth until weaning.
[e] Adjusted to a steer basis. Least-squares adjustment factors for heifers were 2.6 lb for birth weight and 13 lb for 200-day weight.
[f] Ratio computed relative to 452 lb average for Hereford and Angus sired dams.

TABLE 10. ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
CALVING DATE, REBREEDING PERFORMANCE AND SIZE OF COWS CALVING AS 3- AND 4-YEAR-OLD COWS
CYCLE III, PHASE 2 - COW BORN 1975-76

Breed of cow		No. Calving as		Avg.	Percent	Cow weight, lb		Hip Height, in	
Sire	Dam	3-Yr olds	4-Yr olds	calving date	preg.[a]	3½ years	4½ years	3½ years	4½ years
Angus	Hereford	30	21	March 30	98.7	1090	1183	48.6	48.7
Hereford	Angus	68	50	April 4	97.9	1062	1093	47.9	47.6
	Average	98	71	April 1	98.3	1076	1138	48.2	48.2
Pinzgauer	Hereford	41	29	March 29	93.7	1082	1172	49.9	50.6
	Angus	61	43	March 30	96.3	1066	1136	48.6	49.7
	Average	102	72	March 30	95.0	1074	1154	49.2	50.1
Tarentaise	Hereford	31	17	March 31	93.7	1084	1148	50.2	49.8
	Angus	48	17	April 2	95.3	1061	1111	49.2	49.1
	Average	79	34	April 1	94.5	1073	1130	49.7	49.5
Brahman	Hereford	42	30	April 1	97.2	1112	1183	52.0	51.9
	Angus	59	39	April 2	97.2	1113	1203	51.3	51.6
	Average	101	69	April 1	97.2	1113	1193	51.7	51.8
Sahiwal	Hereford	32	13	April 2	95.5	1001	1130	50.3	51.3
	Angus	53	18	March 29	97.0	954	1034	49.1	49.1
	Average	85	31	March 31	96.3	978	1082	49.7	50.2
Average	Hereford	176	110	March 31	95.8	1074	1163	50.2	50.5
all sire	Angus	289	167	April 1	96.8	1052	1115	49.2	49.4
breeds	Average	465	277	April 1	96.3	1063	1139	49.7	49.9

[a] Breeding period was 63 days by natural service to 7/8 Simmental bulls. Percent pregnant = no. palpated as pregnant ÷ no. palpated, and only includes cows that calved prior to breeding.

APPENDIX

TABLE 1. MATING PLANS TO PRODUCE CYCLE I, PHASE 2 CALVES

1969, 1970, 1971 Breeding Seasons

	Sire Breeds						
Dam Breeds	Here-ford	Angus	Jersey	South Devon	Limou-sin	Sim-mental	Charo-lais
Hereford	X	X	X	X	X	X	X
Angus	X	X	X	X	X	X	X

[a] The cows were 1, 2, 3 and 4-year-olds in 1969; 1, 2, 3, 4 and 5-year-olds in 1970; and 2, 3, 4, 5 and 6-year-olds in 1971.

APPENDIX

TABLE 2. MATING PLANS TO PRODUCE CYCLE II, PHASE 2 CALVES

1972 and 1973 Breeding Seasons

	Sire Breeds						
Dam Breeds	Here-ford	Angus	Red Poll	Brown Swiss	Gelb-vieh	Maine Anjou	Chia-nina
Hereford[c]	X	X	X	X	X	X	X
Angus[c]	X	X	X	X	X	X	X
Red Poll	X	X	X	X			
Brown Swiss	X	X	X	X			

[a] The cows were 3, 4, 5, 6 and 7-year-olds in 1972; and 3, 4, 5, 6, 7 and 8-year-olds in 1973.
[b] Sample of same Hereford and Angus sires used in Cycle I, 1969, 1970 and 1971 breeding seasons.
[c] Cows used for GPE Cycle I, 1969, 1970 and 1971 breeding seasons.

APPENDIX

TABLE 3. MATING PLANS TO PRODUCE CYCLE I, PHASE 3 CALVES

Breed Group	Sire Breeds										
	First Calf Crop					Second Calf Crop					Subsequent Calf Crops
	Here-ford	Angus	Brahman	Devon	Hol-stein	Here-ford	Angus	Gelb-vieh	Maine Anjou	Chia-nina	Brown Swiss
H x H		X					X				X
A x A	X					X					X
A x H			X	X	X			X	X	X	X
H x A			X	X	X			X	X	X	X
J x H		X	X	X	X		X	X	X	X	X
J x A	X		X	X	X	X		X	X	X	X
SD x H		X	X	X	X		X	X	X	X	X
SD x A	X		X	X	X	X		X	X	X	X
L x H		X	X	X	X		X	X	X	X	X
L x A	X		X	X	X	X		X	X	X	X
S x H		X	X	X	X		X	X	X	X	X
S x A	X		X	X	X	X		X	X	X	X
C x H		X	X	X	X		X	X	X	X	X
C x A	X		X	X	X	X		X	X	X	X

[a] Females of each breed group distributed equally among cells marked "X" for each calf crop.
[b] Each group of heifers bred as yearlings to produce one calf crop as 2-year-olds by these breeds.
[c] Each group of cows bred as 2-year-olds to produce one calf crop as 3-year-olds by these breeds.
[d] Each group of cows bred to produce at least two calf crops by this breed.
[e] Sample of same sired used in Cycle I, 1969-70-71 breeding seasons.

APPENDIX

TABLE 4. MATING PLANS TO PRODUCE CYCLE II, PHASE 3 CALVES

Female Breeding Groups	First Calf Crop				Subsequent Calf Crops
	Hereford	Angus	Brangus	Santa Gertrudis	Simmental
Hereford		X	X	X	X
Angus	X		X	X	X
Red Poll	X	X			X
Brown Swiss	X	X			X
H x A & Recip.			X	X	X
H x R.P. & Recip.		X	X	X	X
H x B.S. & Recip.		X	X	X	X
A x R.P. & Recip.	X		X	X	X
A x B.S. & Recip.	X		X	X	X
Gelbvieh x Hereford			X	X	X
Gelbvieh x Angus	X		X	X	X
Maine Anjou x Hereford		X	X	X	X
Maine Anjou x Angus	X		X	X	X
Chianina x Hereford		X	X	X	X
Chianina x Angus	X		X	X	X

[a] Females of each breed group distributed equally among the cells marked "X" for each calf crop.
[b] Each group of heifers bred as yearlings to produce one calf crop as 2-year-olds by these breeds.
[c] Each group of cows mated to produce at least three calf crops by 3/4 or 7/8 Simmental bulls.
[d] Sample of same Hereford and Angus sires used in Cycle I, Phase , 1969, 1970 and 1971 breeding seasons.

APPENDIX

TABLE 5. MATING PLANS TO PRODUCE CYCLE III, PHASE 2 CALVES[a]

1974 and 1975 Breeding Seasons

Female Breeds	Male Breeds					
	Hereford	Angus	Brahman	Sahiwal	Pinzgauer	Tarentaise
Hereford		X	X	X	X	X
Angus	X		X	X	X	X

[a] Approximately 256 heifers (32 of each breed group, except Tarentaise) were transferred to Brooksville, Fla. The F_1 heifers were bred naturally to Red Poll bulls for their first calf-crop and to Simmental bulls for subsequent calf-crops.

[b] Cows used for GPE Cycle I, Phase 1.

[c] Sample of same Hereford and Angus sires used in Cycle I, Phase I 1969, 1970 and 1971 breeding seasons.